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ABSTRACT

The hypothesis that high critical thinkers, who rely on plausibility estimates, would be more accurate in rejecting inappropriate inferences than low critical thinkers, who rely on direct matching, was investigated. The supposition that high critical thinkers would suffer more often from a failure to differentiate appropriate inferences from actual facts was also studied. Three experiments were tried in Japan using undergraduate college students. With sentence recognition tasks, the high critical thinkers had higher false alarm rates for appropriate inferences, and lower rates for inappropriate ones, as compared to low critical thinkers. Both groups, however, performed equally well in judging test inference in terms of plausibility while reading and relying upon memory. Results imply, that in order to improve critical thinking ability, it is necessary to encourage students to exploit their potential ability for drawing inferences. (Author/GK)

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The Recognition Memory of Inferences from a Story
among High and Low Critical Thinkers

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When students are asked whether sentences have been included in a previously presented story, they may use at least two procedures; direct matching of test sentences with each of the stored verbatim representations of individual sentences in the story, and plausibility estimates of the test sentences against the total picture constructed through integrating the ideas in the story.

The present study was designed to investigate the hypothesis that high critical thinkers, relying more on plausibility estimates, would be more accurate in rejecting neutral and inappropriate inferences than low critical thinkers, relying more on direct matching, but would suffer more often from a failure to differentiate appropriate inferences from actual facts.

In Exp. I high and low critical thinking undergraduates were given sentence recognition tasks. The high group had significantly higher false alarm rates for appropriate inferences, and lower rates for neutral and inappropriate inferences than low critical thinkers.

In Exp. II and III high and low critical undergraduates were required to judge each test inference in terms of its plausibility while reading (Exp. II) or relying upon memory (Exp. III). Both groups performed equally well in both experiments, showing no marked differences between them.

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What procedures do learners rely on to derive an "OLD-NEW" response to a sentence when they are asked whether it is included in a previously presented ^y story? They may use at least two procedures: firstly, they may compare the test sentence with each of the stored verbatim representations of individual sentences in the story (referred to here as direct matching); secondly, they may decide on OLD-NEW according to the plausibility of the test sentence, considering the total picture constructed by integrating the ideas in the story (plausibility estimate). The clearest evidence for the second procedure can be found in Thorndyke (1976), who showed that undergraduates made many "OLD" responses in recognition tests of a sentence when it was an appropriate inference from the story, but many fewer false alarm OLD responses when the sentence was a neutral or inappropriate inference. This suggests that the student's judgment of OLD or NEW was based upon whether the idea expressed in the test sentence was consonant or dissonant with the total representation of the story. Reder (1979) has claimed that OLD-NEW judgment is always based upon a preceding plausibility estimate. However, it is possible that some learners may depend to some extent upon direct matching for deciding OLD-NEW, in addition to a plausibility estimate. We assume that this reliance on direct matching will be greater among those learners who are relatively poorer at judging the appropriateness of inferences.

Thus the present study was designed to investigate whether the level of critical thinking ability makes any difference in the use of a plausibility estimate and direct matching for deciding OLD-NEW. Critical thinking ability as defined^y_{here}, and explained in detail below, refers to the ability to recognize correctly subtle differences in the validity of inferences. Specifically, we hypothesized that high critical thinkers, relying on a plausibility estimate, would be more accurate in rejecting neutral and inappropriate inferences than low critical thinkers, relying more on direct matching, but would suffer more often from a failure to differentiate appropriate inferences from actual facts.

Experiment I

Tests and Procedure

High and low critical thinking college students, assessed by a Japanese version of the Watson-Glaser Critical Thinking Appraisal, were given a sentence recognition task and a test of episodic memory.

Critical thinking test. Hatano et al. (Note 1) examined and revised "Test 1: Inference" of the Watson-Glaser Critical Thinking Appraisal so as to construct a Japanese version, which had been proven to have the best correlation of all the Watson-Glaser subtests with the reading comprehension of Japanese junior high schoolers. They found that four types of reasoning tasks are involved: 1) formal class reasoning; 2) fuzzy class reasoning, including induction; 3) abbreviated fuzzy conditional reasoning, i.e., inferring "It is likely to be B" from "A", but "If A, then it is likely to be B" being assumed as "common sense"; and 4) recognition of presupposition. The possible conclusions for 1) and 4) are either "true", "false" or "undecided", while for 2) and 3) they are either "probably true",

"probably false" or "undecided", thus five alternative answers were given. Hatano et al. rephrased items of this test so that 2 items of 1), 8 of 2), 6 of 3) and 4 of 4) were included, and the contents were adapted to Japanese culture. Two parallel forms of the test were constructed.

Critical thinking ability as defined here therefore means the ability to recognize differences in the validity of inferences by detailed analysis. Hatano's psychometric analyses (Note 2) have shown that the difference between high and low thinkers in this test decreases markedly when a more lenient scoring system is used (e.g., "true" and "probably true" are both counted as "correct").

The above test (40 items in the two forms) was given to 599 college students enrolling in an introductory psychology course. The top and bottom 30% of the students, 80 high and 74 low critical thinkers, were chosen for the experiment.

Sentence recognition task. The students were given translations of two short stories that had been developed by Thorndyke (1976). The recognition test for each story consisted of 12 sentences, half of which were facts, i.e., original sentences in the story, and two each of the other six were respectively appropriate, neutral, and inappropriate inferences. The students listened to the first story, and then had the interpolated task of rating the story in terms of comprehensibility and two other attributes. This procedure was repeated for the second story. Then, following two more interpolated tasks lasting 18 minutes, the students were given the list of recognition sentences for each of the two stories and required to judge each sentence as to whether or not it had been occurred in the story.

6

Test of episodic memory. In order to get a control variable in the ANOCVA, the students were also given a test of actual or episodic memory, in which they were asked to choose one from several alternatives given of the details of another story, which was also orally presented. The item contents tested were not strongly dependent on the plot of the story, e.g., "amount of money to be collected", "subjects to be tested", etc. Both groups performed equally well on the test, with no noticeable difference (mean scores were 7.58 and 7.31, with a maximum of 10).

Results

The proportion of OLD answers was calculated for each category of sentence for both groups, see Table 1. The high group was slightly

Insert Table 1 about here.

more accurate than the low group in correctly recognizing factual sentences as OLD. ($F(1,152)=8.81, p<.01$).

The high critical thinkers had a significantly higher false alarm rate for the appropriate inferences ($F(1,152)=7.36, p<.01$) and lower rates for the neutral and inappropriate inferences than the low critical thinkers ($F(1,152)=12.80, p<.01$, and $F(1,152)=28.10, p<.01$). Partialing out the effect of episodic memory did not change the above patterns of differences.

The extent of the differentiation between the responses to actual facts and appropriate inferences (discriminated only by direct matching) and between the responses to appropriate inferences on the one hand and neutral and inappropriate inferences combined on the other (discriminated effectively by a plausibility estimate) were

quantified for each student in terms of bivariate information transmission (Attneave, 1959). The high group showed a significantly larger mean than the low group for the differentiation between appropriate and neutral-inappropriate inferences ($t(152)=4.35$, $p<.01$), but an insignificantly smaller mean for the fact-appropriate inference differentiation.

These results are consistent with our hypothesis, i.e., that high critical thinkers rely on a plausibility estimate more, and on direct matching less, than low critical thinkers. However, alternative reasonable interpretations of the obtained results that could not be excluded were 1) that the low students constructed a less accurate integrated picture than the high, and 2) that the low students tended to have a lower ability to judge the plausibility of test sentences when the integrated picture became somewhat vague during retention. In order to examine these two possible alternative interpretations, additional experiments were performed in which high and low students were asked directly to judge the plausibility of inference in test sentences either during reading (Experiment II), or after having performed interpolated tasks (Experiment III).

Experiments II & III

In Experiment II, 51 high and 32 low critical thinking college students, classified in the same way as in Experiment I using the Japanese version of the Watson-Glaser test, but who had not participated in Experiment I, were required to judge each of the 6 test inferences per story in terms of its plausibility, while reading the same two stories. The three possible alternative answers given for the content of each sentence were "probably true, suggested from the story", "may or may not be true" and "probably false, suggested from

the story". Their responses were scored using the authors' judgments of the sentence's appropriateness (appropriate, neutral, and inappropriate) as criteria. Both groups performed equally well, and no difference was found (mean numbers of "correct" judgments were 8.98 for the high group and 8.75 for the low, from a possible maximum of 12). The proportion of "probably true" responses to each category of inference is shown in Table 2. Except for the inappropriate

Insert Table 2 about here.

inferences, the differences between the high and low groups were small and insignificant.

In Experiment III, a further group of 55 high and 50 low critical thinking college students, classified in the same way as in previous experiments, were required to perform the same plausibility judgment task as in Experiment II, but this time relying upon memory. The judgment task was given after an interval of about 40 minutes after reading the two stories, during which time they were given the critical thinking test and another test of critical thinking. Both groups performed equally well, and no marked difference was found between them (mean numbers of correct judgments were 9.22 for the high group and 9.00 for the low). The proportion of "probably true" responses was about the same for the two groups for all categories.

Discussion

We can reasonably assume the homogeneity of the subjects for all three experiments, since all of them were volunteers from introductory psychology courses at one and the same university. This being so, the results of the two additional experiments imply that in

Experiment I also, both the high and low critical thinkers, if they had been asked, could have judged the plausibility of the inferences equally well, having formed an integrated representation of the story equally accurately. Therefore, the fact that they produced different patterns of false alarm responses should be attributed to their use of different recognition procedures. We can conclude, as hypothesized at the beginning, that high critical thinkers tend to rely more on plausibility estimate and less on direct matching than low critical thinkers.

When the 12 inferences were ranked according to the proportion being judged OLD in Experiment I and "probably true" in Experiment III, the rank correlations were equally high (.91 for the high and .92 for the low). The judgements OLD and "Plausible" seem to share the same set of cues, even among low critical students. However, the differences between the two proportions were much larger among the low students, especially for neutral and inappropriate inferences, and they failed to make NEW responses to some inferences even when they had the information to have judged them not to be true.

Why do low critical thinkers rely on direct matching, which is definitely more demanding in terms of memory load? One possible reason is that they have an overly lowered metacognition of their own inferential ability. They will then be reluctant to rely on inference even when their inferential ability is good enough, as revealed in the present plausibility judgement task, because they think they are poor at drawing inferences. Adding some measure of metacognitive knowledge about their own inferential ability to the present study is necessary to examine this interpretation further. Another possible reason is

that their underdeveloped critical thinking ability is in fact a result of their reluctance to use that ability. If this is the case, in order to improve their critical thinking ability it is necessary to first encourage them to exploit their potential ability for drawing inferences.

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Reference Notes

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Table 1

Proportions of "OLD" Responses to Actual Facts,
and Appropriate, Neutral and Inappropriate
Inferences, for High and Low Critical Thinkers

	facts	appropriate inferences	neutral inferences	inappropriate inferences
High critical thinkers (n = 80)	.84	.76	.24	.14
Low critical thinkers (n = 74)	.78	.67	.38	.35

Table 2

Proportions of "Probably True" Responses to
Inferences for High and Low Critical Thinkers

	Inferences		
	Appropriate	Neutral	Inappropriate
Exp. II (No-memory)			
High (n = 51)	.83	.15	.02
Low (n = 32)	.79	.18	.08
Exp. III (Memory)			
High (n = 55)	.90	.24	.06
Low (n = 50)	.87	.24	.08